A

Research Proposal

on

"Multidimensional Scaling and Neural Network Based Sensor Node Localization for Internet of Things"

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INTRODUCTION

Wireless Sensor Networks (WSNs) being a major part of communication have a wide research scope. A Wireless Sensor Network consists of a number of miniature sized electronic devices known as sensors or nodes, deployed in a geographical region. Each such device in the network is capable of sensing, processing and communicating the data from the area in which it is deployed. These electronic devices forming the network transmit the sensed information to the Base Station (BS) or a common sink. Data can be sent directly to the sink node or it can be transmitted using a gateway or some relay node [4] as shown in Fig. 1.

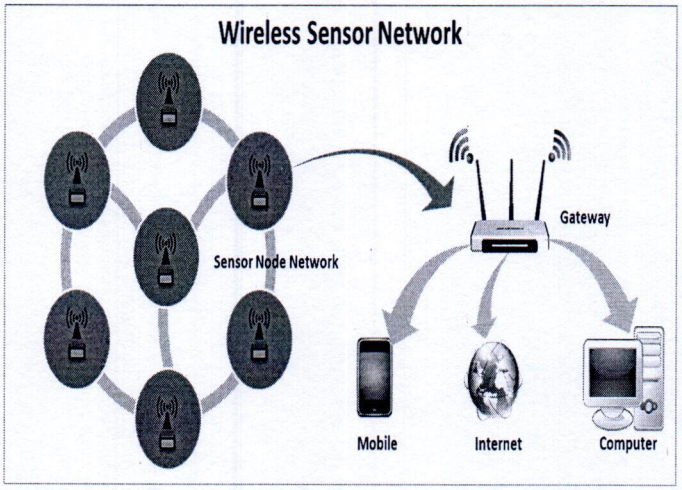

Fig. 1. Wireless Sensor Network Arrangement

Internet of Things (IoT) has a wide range of applications, including target tracking, vehicle tracking, event detection, people monitoring, forest fire detecting [6], routing and, etc. In these applications gathered information are not usable without thinking about the area of an occasion which is the area of the sensor. Limitation is a basic issue in the WSN innovation. Restriction issue alludes to the way toward evaluating and figuring the places of sensor hubs [2]. The significance of this reality drove specialists to look for an answer for localization issue. One simple way is manual arrangement yet this is unreasonable in expansive scale or when sensors are conveyed in difficult to reach regions, for example, volcanoes or when

sensors are versatile. Another route is to include worldwide situating framework (GPS) to every sensor. GPS has influenced by overwhelming trees and structures since it requires viewable pathway between the beneficiary and satellites. Along these lines, it has low exactness because of poor signal gathering. In extra, utilizing GPS in huge scale is not economically productive. Accordingly, a few localization calculations acquainted to solve localization issue.

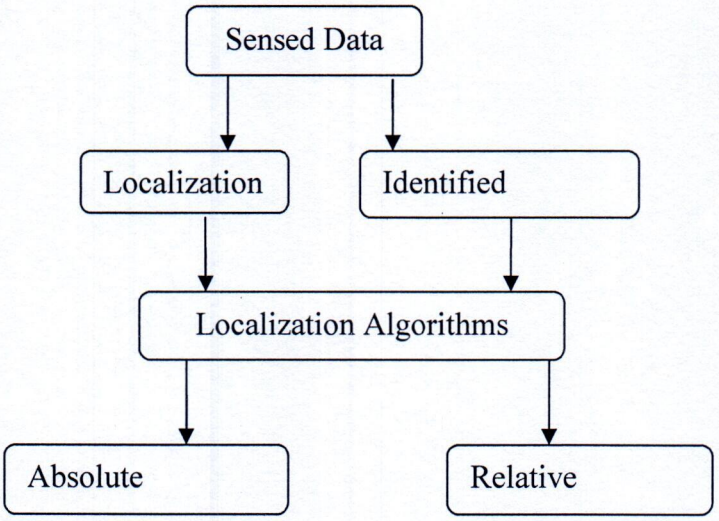

Fig. 2: Localization Process

A localization algorithm localizes mobile nodes based on input data. If there is any anchor device available in the network, the most common parameters are the position of anchors. Different data sources are topology and availability data for range free strategies, separation or edge between hubs for range based methods. By and large, the yield of localization calculation for anchor based systems is absolute coordinates and for range free strategies is relative coordinates. Each progression will be talked about in the following parts of the paper (Fig. 2).

LITERATURE REVIEW

One of the easiest ways to identify the location is the physical configuration, but it is not practically possible in big networks or when sensors are positioned in unreachable areas like volcanoes and underwater [4]. The alternate way is to add Global Positioning System (GPS) to every sensor node. But, GPS does not work efficiently as the line of sight is not available due to high buildings and dense tree areas, needed between satellite and receiver. The poor signal reception may decrease the accuracy. Moreover, using GPS in the large scale area is not cost efficient. Therefore, many location estimating methods have been anticipated to estimate the location of nodes in WSNs [8]. Newly proposed localization methods identify the location of various sensor nodes with the help of location of anchor nodes, which can localize themselves using GPS or by nodes placed at known position, in the network. Localization methods can be classified as *range-based methods* and *range-free methods* [12], according to the mechanisms used for estimating location.

Range based position identifying methods first accurately determine the distance or angle information between the nodes and then with the help of trilateration or triangulation techniques they estimate the desired position of the nodes [11]. Range free localization algorithms establish the communication using radio connectivity to identify their location. Range free algorithms are simple and low cost in comparison to range based techniques as in these schemes, distance measurement, angle of arrival and special hardware are not used [8]. Range free schemes are widely used due to large observable advantages such as conservation in power consumption and low cost [9].

In MDS[3] based localization approach, all distance measurements are collected at one central point (sink node). The sink node has three main tasks:

1. To construct the distance matrix
2. To apply MDS on the distance matrix
3. To convert the relative map into absolute map

If the correct distance matrix is given as input, MDS will reconstruct the map of the network without error. But, calculating distance matrix for network is done by applying Dijkstra's or any other shortest path algorithm.

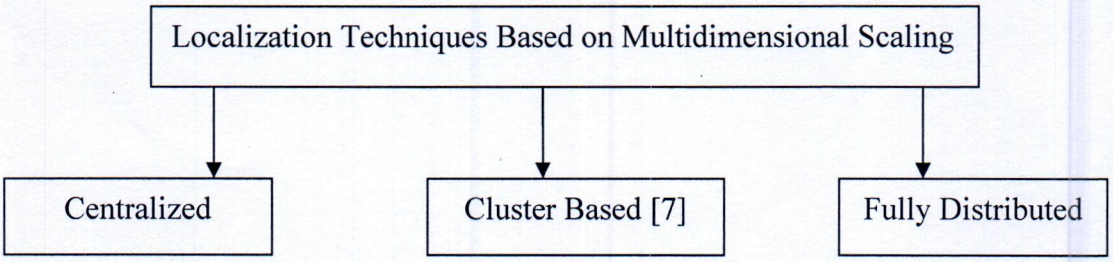

Fig. 3. Computational model for MDS based localization technique

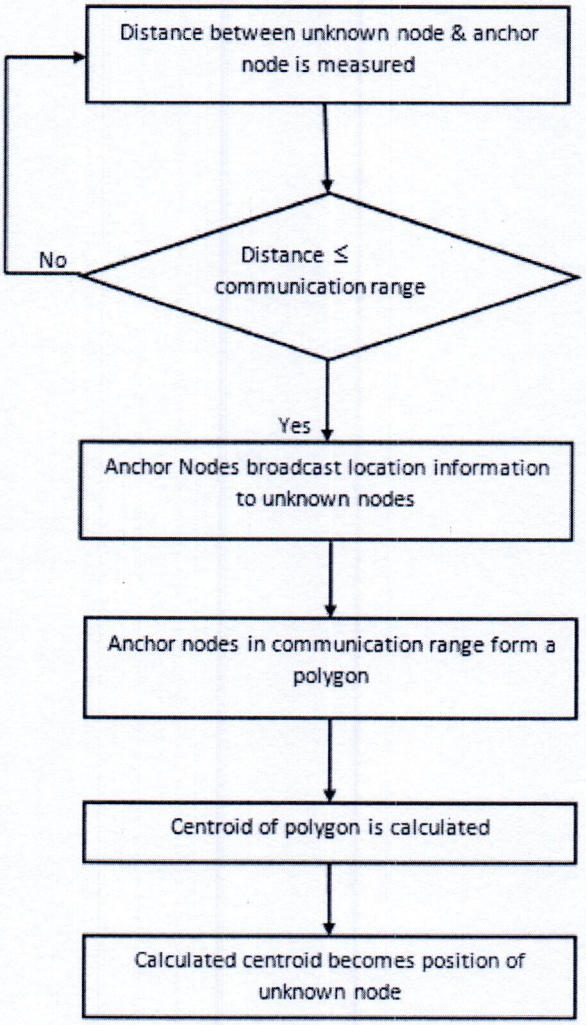
Distance between unknown node & anchor node is measured
Distance ≤ communication range
No
Yes
Anchor Nodes broadcast location information to unknown nodes
Anchor nodes in communication range form a polygon
Centroid of polygon is calculated
Calculated centroid becomes position of unknown node

Fig .4. Flow chart for centroid algorithm

Neural Networks are the interconnections of neurons with activation functions. Neural Networks are trained so that a particular input yields a specific output .Implementing neural networks in wireless sensor networks [1][10] is a promising area for more accurate and faster localization.

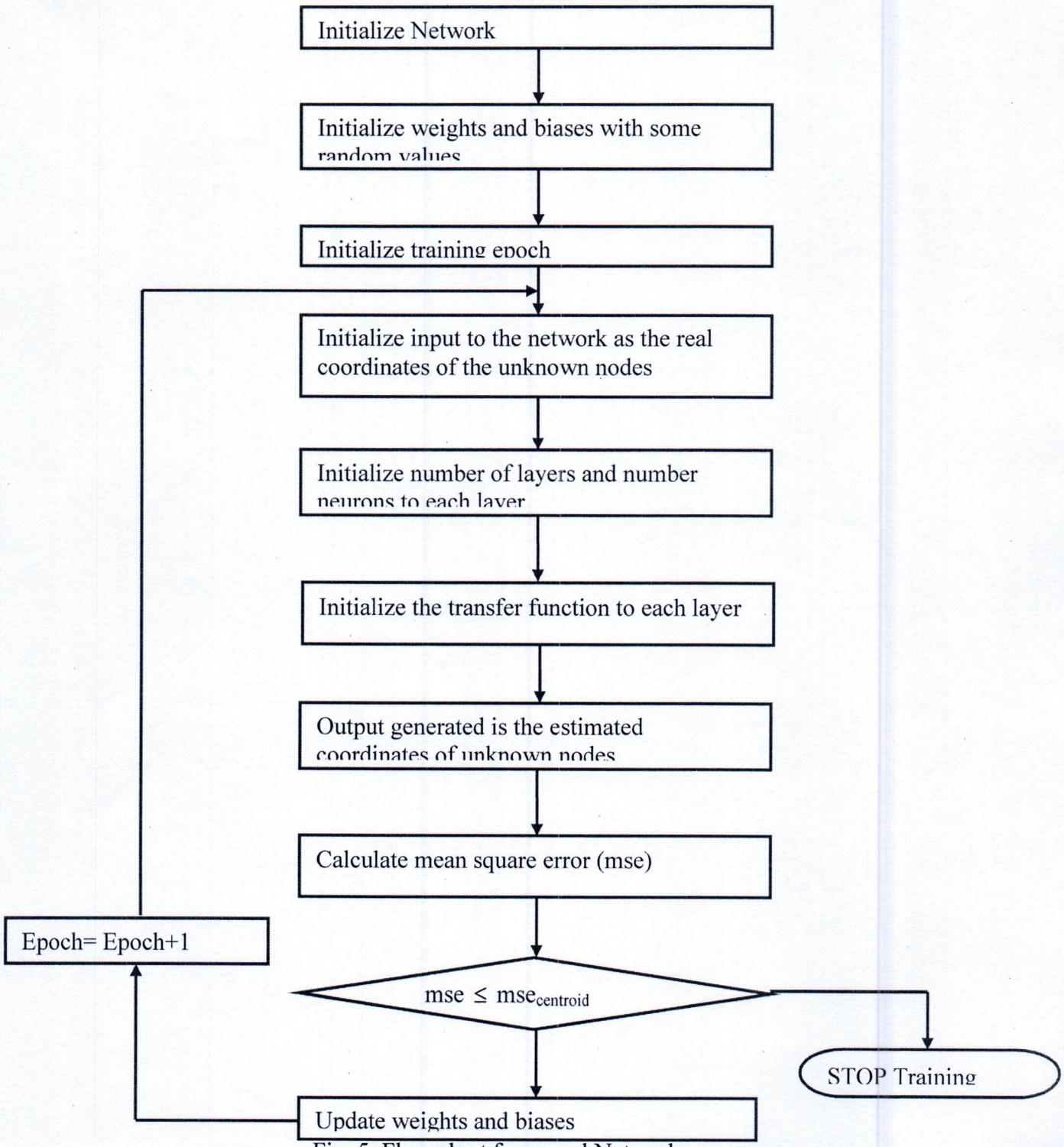
Initialize Network
Initialize weights and biases with some random values
Initialize training epoch
Initialize input to the network as the real coordinates of the unknown nodes
Initialize number of layers and number neurons to each layer
Initialize the transfer function to each layer
Output generated is the estimated coordinates of unknown nodes
Calculate mean square error (mse)
mse ≤ mse centroid
STOP Training
Update weights and biases
Epoch= Epoch+1

Fig .5. Flow chart for neural Networks

RESEARCH GAP

1. The MDS based localization technique is implemented using Djkstra's all pair shortest path algorithm; however other such algorithms may prove to be useful for generating an optimized distance matrix.

Algorithm	Time Complexity	Space Complexity
Djkstra's	O(E+V(logV))	O(V)
Prim's	O(V+E(logV))	O(V)
Bellman Ford	O(EV)	O(V)
Krushkal's	O(ElogV)	O(V)

2. The neural network based approach has not been very common for finding the location of a sensor node in a wireless sensor network for an application in Internet of Things.
3. Comparative analysis of above mentioned localization techniques can be done for different scenarios and applications.

OBJECTIVE OF PROPOSED RESEARCH WORK

The proposed research work will involve the following points:

1) To model, simulate and compare MDS based localization techniques for two dimensional architecture in Internet of Things for regular and irregular proximities.

2) To compare various Neural Network based localization techniques with the range based approach of sensor node localization in Internet of Things.

3) To analyze various shortest path algorithms for calculating Euclidean distance and Manhattan distance to construct the distance matrix for the MDS based centralized approach.

4) To model and apply various shortest path algorithms for Cluster based MDS localization techniques for two dimensional and three dimensional architecture.

5) To apply and compare various MDS based localization techniques and Neural network based localization techniques with different shortest path algorithms (for Multidimensional Scaling) and with different weights and biases (for neural network).

6) To propose a new method using Heuristic based shortest path algorithm and comparison with the existing methods.

APPROACH / METHODOLOGY INTENDED TO BE ADOPTED

The proposed work will be conducted on the simulator, MATLAB and the QualNet. It will involve the implementation of wireless network and identifying the location of a node for 2D and 3D architecture using different localization approaches.

Objective 1: To model, simulate and compare MDS based localization techniques for two dimensional architecture in Internet of Things for regular and irregular proximities.

The two dimensional architecture is suitable for flat indoor and outdoor environment. Though WSNs can be deployed in both the 2D and 3D architectures but according to the applications more feasible and advantageous architecture will be selected. The work may involve identifying the location of an algorithm and the structure of network for the application in Internet of things.

Objective 2: To compare various Neural Network based localization techniques with the range based approach of sensor node localization in Internet of Things.

This may be achieved by simulating the different neural network based approaches and comparing with centroid approach of node localization with variable number of anchor nodes, unknown nodes, deployment area and communication range. The different neural networks which can be simulated are:

a) Feed forward neural network
b) Radial basis neural network
c) Recurrent neural network

Objective 3: To analyze various shortest path algorithms for calculating Euclidean distance and Manhattan distance to construct the distance matrix for the MDS based centralized approach.

The MDS based localization approach depends upon the calculation of distance matrix for step 2 of the process. Different algorithms for finding the shortest path among the sensor nodes available in the network and be used. The different available algorithms are needed to

be analyzed for their space and time complexities and the efficiency of the process for different types of sensor networks. Following algorithms will be studied and applied on different MDS based localization approaches. This will be done by implementing the standard shortest path algorithms for the basic network with limited nodes and may be varied with scaled network to obtain the desired results.

a) Prim's algorithm
b) Kruskal's algorithm
c) Bellman's Ford algorithm
d) Djkstra's algorithm

Objective 4: To model and apply various shortest path algorithms for Cluster based MDS localization techniques for two dimensional and three dimensional architecture.

Study of cluster based localization, forming sensor node clusters and applying the methods and algorithms of Objective 2 for achieving the optimized results for different types of cluster formation like C-shape, I-shape and H-shape.

Objective 5: To apply and compare various MDS based localization techniques and Neural network based localization techniques with different shortest path algorithms (for Multidimensional Scaling) and with different weights and biases (for neural network).

Implementation of centroid algorithm, implementing MDS based localization techniques with different shortest path algorithms and comparing with different types of neural networks as mentioned above.

Objective 6: To propose a new method using Heuristic based shortest path algorithm and comparison with the existing methods.

A new method will be designed using the Heuristic based (A* algorithm) shortest path algorithm which yields shortest path with optimum cost.

EXPECTED OUTCOME OF PROPOSED RESEARCH WORK

An efficient localization technique with minimum approximation error and best among the various MDS and neural network based localization technique will be the expected outcome of the research.

The proposed research work will be relevant in the following manner:

1) Figuring out which architecture out of 2d and 3D will be more feasible in any specific application when applied to.
2) Implementation of localization technique using CB-MDS and neural network based.
3) The best distance matrix generation algorithm can be identified for localization for flat indoor and outdoor environment.
4) The comparison of MDS based and neural network based approach and the best among the both will be the expected outcome.
5) A* algorithm (Heuristics based) based algorithm for finding the distance matrix for MDS based localization.

Lastly, there will be help in the determining the methods for node localization and the possible order in which the methods can be applied to obtain the optimized results.

GANTT CHART

Time →		TILL NOV 2017		TILL FEB 2018		TILL MAY 2018		TILL SEP 2018		TILL DEC 2018
Objectives ↓										
Objective 1										
Objective 2										
Objective 3										
Objective 4										
Objective 5										
Objective 6										

PUBLICATIONS

- Ajay Kumar, V. K. Jain, " Taxonomy of Localization Techniques for Internet of Things", 3rd National Conference on Future and Scope of Data Science and Engineering for Digital India, at Maharishi Arvind Institute of Engineering and Technology, Jaipur, 2017.
- Ajay Kumar, V. K. Jain , "Feed Forward Neural Network Based Sensor Node Localization in Internet of Things", International Conference on Computing Analytics and Networking (ICCAN) 2017, KIIT University, Bhubaneswar, Orissa (Accepted)
- Ajay Kumar, V. K. Jain, "Neural Network Based Sensor Node Localization in Internet of Things", International Journal of Scientific Research and Development (IJSRD), Volume 5, Issue 7, Sep 2017. (Communicated)

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